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(Under International Convention.)

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Complete Specification Left, 8th Jan., 1896—Accepted, 15th Feb., 1896

### PROVISIONAL SPECIFICATION.

#### Improvements in and Apparatus for Sterilizing Liquids.

I, ETIENNE WILLIAMS KUHN of 42 Rue du Louvre, Paris, in the Republic of France, Engineer, do hereby declare the nature of this invention to be as follows:—

The object of my invention is to provide a process of, and apparatus for the absolute and scientific sterilization of liquids consisting in submitting them to the action of heat and cold alternately, as and under the conditions hereinafter explained so that the effect is homogeneous and takes place as instantaneously as practicable throughout the body of liquid. The operations are performed in a tightly closed chamber, preferably horizontal, and capable of receiving oscillatory, gyratory, or equivalent movement such of the gases contained in the liquid treated which tend to become disengaged during the heating, being retained and subjected to such a pressure that during cooling, they are re-absorbed by the liquid. The action due to the metallic vessel and the transformations which would result therefrom in the liquids under treatment are entirely avoided by coating the inner surfaces of the chamber with silver or a metal such as those hereinafter defined.

The various applications of heat which have hitherto been tried for the sterilization of liquids and more particularly for the sterilization of fermented liquids, have not given quite satisfactory results for manufacturing purposes partly because the processes employed do not permit the treatment of sufficiently large masses at one operation, and partly because the changes brought about in the nature, or condition of the liquid, by the treatment to which it was subjected in apparatus such as have been used hitherto prevented the general application of the processes.

The failures met with hitherto are explainable from the fact that the necessary conditions as regards homogeneous and complete sterilization and the retaining the liquid in an unaltered condition physically and chemically or organically have never been before adequately obtained at one and the same time.

The absence of homogeneity or regularity in the effect produced and of completeness in sterilization is owing both to the absence of uniformity in and the slowness of heating and cooling. The fact that the temperature is not regular throughout the mass of liquid arises from the liquids being bad conductors of heat so that it is not evenly diffused and consequently the transformation is not the same throughout the different portions of the liquid unless the liquid be submitted to agitation. The agitating or stirring devices hitherto employed for this purpose have been attended by serious drawbacks as they interfered with the tightness of

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▲



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the chambers or receivers used or gave rise to the danger of considerable losses of gas especially of carbonic acid gas in the case of fermented liquid which gas in escaping carries away with it the aromatic principles which impart the peculiar qualities to certain liquids ; such as beer for example.

One of the reasons which have caused the abandonment of previous sterilizing methods is due to certain peculiar and hitherto inexplicable disturbances which take place in the liquids which are treated and which may manifest themselves some considerable time after the operation. These disturbances have been hitherto attributed to the action of heat but I have found by analysis that these disturbances are due to the partial decomposition produced by contact with the metals hitherto employed and that the only metals which will not cause such disturbances are platinum, gold, silver, and certain other metals of the same class, such as palladium, and iridium. When metals other than these, come into contact with a heated and fermented liquid, metallic hydroxides form and these react upon the nitrogeneous and albuminoid matters contained in the liquid, and cause them to be precipitated. Other reactions of a very complicated nature also take place between the organic acids and metals ; which reactions it is particularly important to avoid especially where beer or milk for instance, is the liquid treated.

The object of this invention is to provide a process whereby the various inconveniences and objections above referred to are entirely avoided. It consists in obtaining homogeneous, regular, and perfect sterilization without any physical, chemical or organic change taking place in the liquid treated. This I effect by subjecting the liquid as rapidly as possible (without however superheating any part thereof) to the sterilizing temperature, and then rapidly bringing it down again to its initial temperature, by causing heated and cooled liquids to alternately circulate in such a manner that the liquid being treated is presented in strata, of but small depth, to the action of the heat and cold alternately.

The operation is carried out in a perfectly tightly closed receiver, capable of resisting very high pressures such as those to which the liquid to be sterilized exerts owing to the elevated temperature to which it has to be brought. An oscillatory, gyratory or equivalent movement, of any suitable description is imparted to the said closed receiver for rendering the temperature even, or homogeneous throughout the liquid under treatment.

The said process may be carried out by means of apparatus of various forms ; but I prefer a horizontal cylinder, or vessel of small diameter or width compared to its length.

It is advisable for example, that the length of the cylinder or vessel should be at least six times greater than its diameter so that the liquid layer shall have but little height, or depth, and by this means differences of temperature between the top and bottom portions of the liquid are avoided.

To this cylinder a gyratory, or oscillatory, or equivalent, movement can be imparted by mounting it upon spindles, pivots, rollers, or other similar devices enabling it to be rotated or partially rotated through an angle varying say between 180 degrees in each direction that is permitting it to complete an entire semi-revolution in each direction so that what was before the top of the apparatus, becomes its bottom, and *vice versa*, whereby an intermixture of the liquid layers is effected and the liquid is consequently prevented from becoming divided into layers, or zones, differing in temperature and density. The said cylinder, or vessel, is provided with an outer casing, or jacket, and with tubes running through its interior for the passage of the heating and cooling medium and the motion imparted to it whilst enabling it to remain tightly closed, has the effect of causing the said internal tubes to act as an agitating device of great efficacy which in the most satisfactory manner effects the complete mixture of the liquid and ensures homogeneousness of treatment throughout.

To avoid the treatment causing changes in the taste, flavour or odour, in the liquids, treated the time of heating is made as short as possible too intense a heat being avoided but the heating surfaces being as numerous, or extended, as



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possible. Physiological effects are more rapidly obtained than physical or chemical effects, and they bear a more direct relation to the factor "temperature" than to the factor "time" so that by rapid and brief application of high temperature a zymotechnical sterilising effect is obtained, and, on this being obtained, the  
5 application of heat should cease before it has time to bring about a chemical, or physical, effect such as boiling, or other cause of undesirable changes due to the continued action of heat. This most important prevention of undesirable changes is effected by means of the inner tubes, and the outer casing, and the passage there-  
10 through of a heating agent and then of an intensely cold agent, such as ice water, or incongealable cold liquid. This combination of means enables the liquid treated to be raised to the sterilizing temperature in a short time and to be maintained at that temperature just as long as, and not longer than the time strictly necessary for the attainment of the desired sterilising effect. When this is attained, the liquid treated is immediately cooled down to its original temperature, the maintenance of  
15 any intermediate temperature liable to prove harmful being carefully avoided. This method enables sterilisation to be attained in a satisfactory manner whilst avoiding the least modification in the taste odour or nature, of the liquid treated; and it gives a result totally different from that obtained by the slow heating and cooling processes performed in bottles.

20 By plating with silver, or other like metals, as hereinbefore defined the metal surfaces with which the liquids to be sterilised (more particularly fermented liquors) would otherwise come into contact, decomposition is entirely avoided, and therefore those injurious disturbances, which hitherto have been solely ascribed to heat are prevented.

25 The apparatus employed may be arranged as follows. It consists of a tightly closed cylinder say of copper. Its interior is silver-plated and it has a length about six times greater than its diameter. It is arranged horizontally and traversed longitudinally by a series of tubes set very closely together, and say of copper and they are silvered on their exteriors. These tubes are arranged in horizontal  
30 tiers and their ends are secured in front to the end plate over which is fixed a box, or chamber, forming the end of the apparatus, the said box or chamber being divided into a number of superposed compartments into which the ends of the tubes open so as to constitute with the said tubes a continuous passage. This chamber is connected with the cylinder by very closely set bolts, so that a  
35 hermetically closed joint is formed. The bottom and top compartments have respectively connected with them pipes constituting the inlet and exit for the heating and cooling fluid.

The said cylinder is covered by a jacket with an inlet at one end and an outlet at the other end for the entrance and exit of the heating and cooling fluid, to and  
40 from; the space between the jacket and cylinder. The said cylinder is supported by rings which rest on rollers supported by a framing or support.

The apparatus is provided at the end with a pressure gauge a thermometer or temperature indicator a liquid gauge, a filling and discharge cock and an air exhaust cock. To the cylinder, handles are secured which enable the operator to  
45 impart oscillation in both directions to the said cylinder with the greatest ease and with the requisite amplitude of movement (no matter what the dimensions, or the weight, of the apparatus may be) owing to its being supported on rollers. In the case of very large sized apparatus one of the rings may be replaced by a toothed wheel with which engages a pinion by means of which rotary motion can be given  
50 to the cylinder.

The liquid to be sterilised having been filtered, or strained, if necessary, is, under pressure, conveyed through the inlet pipe and cock into the cylinder, while the air contained in the latter escapes through an outlet or discharge cock therefor.

A line marked upon the water gauge indicates the point which should not be  
55 exceeded in the level of liquid in the cylinder so as to allow of the necessary space above for gases from the liquid under treatment, and of the requisite pressure, being attained.



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When the apparatus is filled sufficiently the cocks which were opened are close l.  
 Hot water from any suitable source of supply is then admitted through the inlet  
 pipes therefor, which are fully opened for the purpose. The temperature of such  
 water should not exceed, by more than 10 degrees, the final temperature required  
 for sterilization, as any contact between the liquid treated and a surface heated to 5  
 a higher temperature would cause changes to occur in those portions of the liquid  
 so brought into contact with the superheated surfaces, and it is an object in  
 carrying out my invention to avoid this by ensuring absolute uniformity of heating  
 effect throughout the liquid under treatment. The hot water flows through the  
 rows of tubes in succession and through the compartments, so that it traverses the 10  
 said tubes in two directions passing from one end of the apparatus to the other and  
 then back again alternately, thus exerting its maximum heating effect in a  
 thoroughly equalized way upon the liquid under treatment.

On arriving at the upper compartment the liquid escapes through the outlet  
 therefor. 15

Hot water also passes through the jacket entering by the inlet and leaving by  
 the outlet.

The liquid to be treated being thus on all sides in contact with the heating  
 medium is, in a short time, raised to sterilising heat and when this has been attained  
 the supply of hot water is discontinued after the zymotechnical and physiological 20  
 effects of destruction of micro-organisms, or bacteria, have been produced, care  
 being taken to impart to the cylinder rotary, or oscillatory, movements, preferably  
 not less than 180 degrees in amplitude, the effect of such movements being to render  
 the temperature of the whole liquid mass perfectly uniform, or homogenous. The  
 pipes connected with the apparatus may be made of indiarubber, or other flexible 25  
 material, to enable them to follow the movements of the cylinder. When the  
 desired result is attained there is admitted through the same orifices as those by  
 which the hot water was previously admitted, and caused to circulate in the same  
 manner, ice water at about the zero temperature or, better still, incongealable  
 liquid at -10 degrees supplied from cold producing machines, which cooling 30  
 medium causes instantaneous cooling of the liquid under treatment to take place  
 and in a very short time the whole of the liquid will in consequence fall to its  
 initial low temperature.

During this cooling process, all the gases and vapours expelled but retained in  
 the cylinder during the heating process are again dissolved, resolved, and wholly, 35  
 absorbed by the cooled liquid.

The operation is then completed and the sterilised liquid, the other properties of  
 which have undergone no alteration whatever, may be decanted or drawn off for  
 use, or be introduced into casks, or other vessels, for shipment, or storage, the  
 necessary precautions of an antiseptic, or isobarometric, nature, being taken, so as 40  
 to avoid any infection from noxious germs and any subsequent loss of gas.

Dated this 9th day of April 1895.

JOHNSONS & WILLCOX,  
 47 Lincoln's Inn Fields, London, W.C., Agents.

## COMPLETE SPECIFICATION. 45

## Improvements in and Apparatus for Sterilizing Liquids.

I, ETIENNE WILLIAMS KUHN of 42 Rue du Louvre, Paris, in the Republic of  
 France, Engineer, do hereby declare the nature of this invention and in what  
 manner the same is to be performed to be particularly described and ascertained  
 in and by the following statement:— 50

The object of my invention is to provide a process of, and apparatus for, the  
 absolute and scientific sterilization of liquids, consisting in submitting them to the



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action of heat and cold alternately as, and under the conditions, hereinafter explained; so that the effect is homogeneous, and takes place as instantaneously as practicable throughout the whole body of liquid. The operations are performed in a tightly closed horizontal, or approximately horizontal, chamber, or vessel, capable of receiving oscillatory, gyratory, or equivalent, movement, the liquid occupying such a portion of the space inside the chamber, or vessel, that such of the gases and volatile principles contained in the liquid treated, which tend to become disengaged during the heating, are retained by the liquid after it has been cooled. The action due to the metallic chamber, or vessel, and the transformations which would result therefrom, in the liquids under treatment are entirely avoided by coating the inner surfaces of the chamber, or vessel, and the parts within it, with silver, or a metal such as those hereinafter defined.

The various applications of heat, which have hitherto been tried for the sterilization of liquids, and more particularly for the sterilization of fermented liquids, have not given satisfactory results for manufacturing purposes, partly because the processes employed did not permit the treatment of sufficiently large masses of liquid at one operation, and partly because the changes brought about in the nature, or condition, of the liquid, by the treatment to which it was subjected, in apparatus such as have been hitherto used, prevented the general application of the processes.

The failures hitherto met with are due to the fact that, up to the present, means have never been provided which fulfilled the necessary conditions for homogeneous and complete sterilization whilst retaining the liquid in an unaltered condition physically, chemically, and organically, and so as not to injure their value for human consumption.

The absence of homogeneity, or regularity in the effect produced, and of completeness in sterilization, is owing both to the absence of uniformity in, and the slowness of, heating and cooling. The fact that the temperature is not regular throughout the mass of liquid, arises from the liquids being bad conductors of heat, so that it is not evenly diffused, and consequently the temperature is not the same throughout the different portions of the liquid unless the liquid be submitted to agitation. The agitating, or stirring, devices hitherto employed for this purpose have been attended by serious drawbacks, as they interfered with the tightness of the chambers, or receivers, used, or gave rise to the danger of considerable loss of gas, especially of carbonic acid gas, in the case of treating fermented liquid, which gas, in escaping, carries away with it the aromatic principles which impart the peculiar qualities to certain liquids, such as beer, for example.

One of the reasons which have caused the abandonment of previous sterilizing methods is due to certain peculiar, and hitherto inexplicable, disturbances which take place in the liquids which are treated, and which may manifest themselves some considerable time after the operation. These disturbances have hitherto been attributed to the action of heat, but I have found, by analysis, that they are due to the partial decomposition produced by contact with the metals hitherto employed for the apparatus, and that the only metals which will not cause such disturbances are silver, platinum, gold and certain other metals of the same class, such as palladium and iridium. I will hereinafter refer to the metal which I use as silver, as that is the metal practically best adapted for the purposes of my invention. When metals other than these, come into contact with a heated and fermented liquid, metallic hydroxides, form and these react upon the nitrogenous and albuminoid matters contained in the liquid, and cause them to be precipitated. Other reactions of a very complicated nature, also take place between the organic acids, and the metals, which reactions it is particularly important to avoid, especially where beer, or milk, for instance; is the liquid treated.

The object of this invention is to provide a process whereby the various inconveniencies and objections hereinbefore referred to are entirely avoided and homogeneous, regular, and perfect, sterilization is obtained without any physical,



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chemical, or organic, change taking place in the liquid treated, or its value for human consumption being detrimentally affected. This I effect by subjecting the liquid, as rapidly as possible, (without however superheating any part thereof), to the sterilizing temperature, and then rapidly bringing it down again to its initial temperature, by causing heated and cooled liquids to alternately circulate in such a manner that the liquid being treated is presented in strata of but small depth, to the action of the heat and cold alternately. 5

The operation is carried out in a perfectly tightly closed chamber, vessel, or receiver, capable of resisting very high pressures, such as those which the liquid to be sterilized exerts owing to the elevated temperature, to which it has to be brought. An oscillatory, gyratory, or equivalent, movement is imparted to the said closed vessel, or receiver, for rendering the temperature even, or homogeneous, throughout the liquid under treatment. 10

The said process may be carried out by means of apparatus of various forms, but I prefer a horizontal cylinder, or vessel, of small diameter, or width, compared to its length. 15

It is advisable, for example, that the length of the cylinder, or vessel, should be at least six times greater than its diameter, so that the liquid layer shall have but little height, or depth, and, by this means, differences of temperature between the top and bottom portions of the liquid are avoided. 20

To this cylinder, or vessel, a gyratory, or oscillatory, or equivalent, movement can be imparted by mounting it upon spindles, pivots, rollers, or other similar devices, enabling it to be partially rotated through an angle, varying say between 180 degrees in each direction; that is permitting it to perform a semi-revolution in each direction, so that what was before the top of the apparatus, becomes its bottom and *vice versa*, whereby an intermixture of the liquid layers is effected, and the liquid is consequently prevented from becoming divided into layers, or zones, differing in temperature and density. The said cylinder, or vessel, is provided with an outer casing, or jacket, and with tubes, or equivalent passages, running through its interior for the passage of the heating and cooling medium, and the motion imparted to it, whilst enabling it to remain tightly closed, has the effect of causing the said internal tubes, or passages, to act as an agitating device of great efficacy, which in the most satisfactory manner, effects the complete mixture of the liquid, and ensures homogeneousness of the treatment throughout. 25 30

To prevent the treatment causing changes in the taste, flavour, or odour, of the liquids treated, the time of heating is made as short as possible, too intense a heat being avoided, but the heating surfaces being as numerous, or extended, as possible. Physiological effects are more rapidly obtained than physical, or chemical, effects, and they bear a more direct relation to the factor "temperature," than to the factor "time," so that, by rapid and brief application of high temperature, a zymotechnical sterilizing effect is obtained, and, on this taking place, the application of heat should cease before it has time to bring about a chemical, or physical, effect, such as boiling, or other cause of undesirable change, due to the continued action of heat. The inner tubes, or passages, and the outer casing, and the passage therethrough of a heating agent, and then of an intensely cold agent, such as ice-water, or incongealable cold liquid, or brine, enables the liquid treated to be raised to the sterilizing temperature in a short time, and to be maintained at that temperature, just as long as, and not longer than, the time strictly necessary for the attainment of the desired sterilizing effect. When this is attained the liquid treated is immediately cooled down to its original temperature, the maintenance of any high, or intermediate, temperature, liable to prove harmful, being carefully avoided. This method enables sterilization to be attained in a satisfactory manner, whilst avoiding the least modification in the taste, odour, or nature, of the liquid treated, and it gives a result totally different from that obtained by the slow heating and cooling processes performed in bottles, or like receptacles, in which the conditions hereinbefore defined have not been provided for. 35 40 45 50 55



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By plating with silver, or other like metals, as hereinbefore defined, the injurious metal surfaces with which the liquids to be sterilized, (more particularly fermented liquors), would otherwise come into contact, decomposition is entirely avoided, and the injurious disturbances, which hitherto have been solely ascribed to heat, but  
 5 are due to contact with such injurious metal surfaces are prevented.

In the accompanying drawings I have shewn an apparatus suitable for use in carrying this invention into effect, but I do not limit myself to the use of the particular form, or proportions, of apparatus illustrated.

Figure 1, is an elevation of the apparatus partly in section, and

10 Figure 2, is an end view of the same seen from the entrance, or admission, end, (being the left hand end of Figure 1).

The apparatus consists of a tightly closed cylinder A, say of copper. Its interior is silver plated, and it has a length of, say, at least, about six times greater than its diameter. It is arranged horizontally, or practically horizontally, and is  
 15 traversed longitudinally by a series of tubes B, set very closely together, and say of copper, and they are silvered on their exteriors. These tubes are arranged in horizontal tiers, and their ends are secured in front to the end plate, over which is fixed a box, or chamber, C, forming the end of the apparatus, the said box, or chamber, C, being divided into a number of superposed compartments *c*, into which  
 20 the ends of the tubes B, open, so as to constitute, with the said tubes, a continuous passage. This chamber C, is connected with the cylinder by very closely set bolts, so that a hermetically closed joint is formed. The bottom and top compartments *c*, have respectively connected with them, the pipes D, and E, constituting the inlet and exit for the heating and cooling agent.

25 The said cylinder A, is covered by a jacket F, with an inlet at one end, and an outlet at the other end (*f*, *f*<sup>2</sup>), for the entrance and exit of the heating and cooling fluid, to, and from, the space between the jacket F, and cylinder A. The said cylinder A, is supported by the rings *a*, which rest on rollers *g*, supported by the framing, or support, G.

30 The apparatus is provided at the end with a pressure gauge H, a thermometer, or temperature indicator, I, a liquid gauge J, a filling and discharge cock K, and an air exhaust cock L. To the cylinder A, handles *a*<sup>2</sup>, are secured which enable the operator to impart oscillation in both directions to the said cylinder with the greatest ease, and with the requisite amplitude of movement, (no matter what the  
 35 dimensions, or the weight, of the apparatus may be), owing to its being supported on rollers. In the case of very large sized apparatus one of the rings *a*, may be replaced by a toothed wheel, with which engages a pinion by means of which semi-, or partial rotary motion can be given to the cylinder A, or any other suitable means for giving the necessary motion to the cylinder can be used.

40 The liquid to be sterilized having been filtered, or strained, if necessary, is, under pressure, conveyed through the pipe and cock K, into the cylinder A, while the air contained in the latter, escapes through the outlet, or discharge, cock L.

A line, marked upon the liquid gauge J., indicates the point which should not  
 45 be exceeded in the level of liquid in the cylinder, so as to allow of the necessary pressure being attained and of the necessary space above for permitting the gases and volatile principles of the liquid under treatment to remain in such a way that chemical disassociation is prevented and retention of the said gases and volatile principles is ensured when the pressure is relieved on cooling.

50 When the apparatus is filled sufficiently the cocks K, and L, are closed. Hot water, or other heating agent, from any suitable source of supply, is then admitted through the pipes D, and *f*, which are fully opened for the purpose. The temperature of such water, or heating agent, should not exceed by more than say 10 degrees, the final temperature required for sterilization, as any contact between  
 55 the liquid treated and a surface heated to a higher temperature would cause changes to occur in those portions of the liquid so brought into contact with the superheated surfaces, and it is an object in carrying out my invention to avoid



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this by ensuring absolute uniformity of heating effect, throughout the liquid under treatment. The hot water, or other heating agent, flows through the rows of tubes B, in succession, and through the compartments c, as indicated by the arrows, so that it traverses the said tubes in two directions, passing from one end of the apparatus to the other, and then back again alternately, thus exerting its maximum heating effect in a thoroughly equalized way upon the liquid under treatment, and, on arriving at the upper compartment c, the liquid escapes through the outlet E.

Hot water, or other heating agent, also passes through the jacket F, entering by the inlet f, and leaving by the outlet f<sup>2</sup>.

The liquid to be treated being thus in contact on all sides with the heating medium is, in a short time, raised to sterilizing heat, and, when this has been attained, the supply of hot water, or other heating agent employed, is discontinued after the zymotechnical and physiological effects of the destruction of microorganisms, or bacteria, have been produced, care being taken to impart to the cylinder A, alternating-rotary, or oscillatory, movements, preferably not less than 180 degrees in amplitude, the effect of such movements being to render the temperature of the whole liquid mass perfectly uniform, or homogeneous. The pipes connected with the apparatus, may be made of india rubber, or other flexible material, to enable them to follow the movements of the cylinder. When the desired result is attained, there is admitted, through the same passages as those by which the hot water, or other heating agent, was previously admitted, and caused to circulate in the same manner, the cooling agent, say ice water, at about the zero temperature, or, better still, incongealable liquid at -10 degrees C. supplied from cold producing machines, which cooling medium causes instantaneous cooling of the liquid under treatment to take place, and in a very short time, the whole of the liquid will in consequence fall to its initial low temperature.

During this cooling process, all the gases and volatile principles are retained by the cooled liquid which thus does not lose its original properties.

The operation is then completed and the sterilised liquid, the other properties of which have undergone no substantial alteration whatever, may be decanted, or drawn off, for use, or be introduced into sterilized casks, or other vessels, for shipment, or storage, if necessary the precautions being taken of previously washing the vessel with an antiseptic and subsequent introduction of the fluid by isobarometric pressures into such vessels so as to avoid any infection from noxious germs, and any subsequent loss of gas.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:—

1. The hereinbefore described improved process of sterilization of liquids, consisting in first submitting them to the homogeneous and instantaneous action of heat, not however exceeding, (or exceeding very slightly), the temperature necessary for sterilization, and then cooling the same, also in a homogeneous and instantaneous manner, such heating and cooling operations being intermittently performed in a hermetically closed horizontal, or practically horizontal, cylinder, or vessel, to which oscillatory, gyratory, or equivalent, motions are imparted, the conditions being such as aforesaid that the gases and volatile principles of the liquid treated are retained and injurious action of metallic surfaces being avoided by the employment of coatings of silver, or equivalent metal proof against the actions of liquids, such silver, or the like, being applied to the surfaces of, and in, the said cylinder, or vessel, with which the liquid comes in contact, substantially as hereinbefore described.

2. Apparatus for the purpose described; the said apparatus consisting of a tightly closed horizontal, or practically horizontal, cylinder, or vessel, for containing the liquid to be treated, and of a diameter, or width, small in comparison to its length, and provided with a casing, or jacket, and a series of tubes, or passages, in



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the interior of the said cylinder, or vessel, and means for supplying a heating agent and a cooling agent to the said jacket and tubes, or passages, and means for imparting a gyratory, oscillating, or equivalent, motion to the said cylinder, or vessel, the surfaces in, and of, the cylinder being coated with silver, or equivalent metal all substantially as hereinbefore described and illustrated in the accompanying drawings.

Dated this 8th day of January 1896.

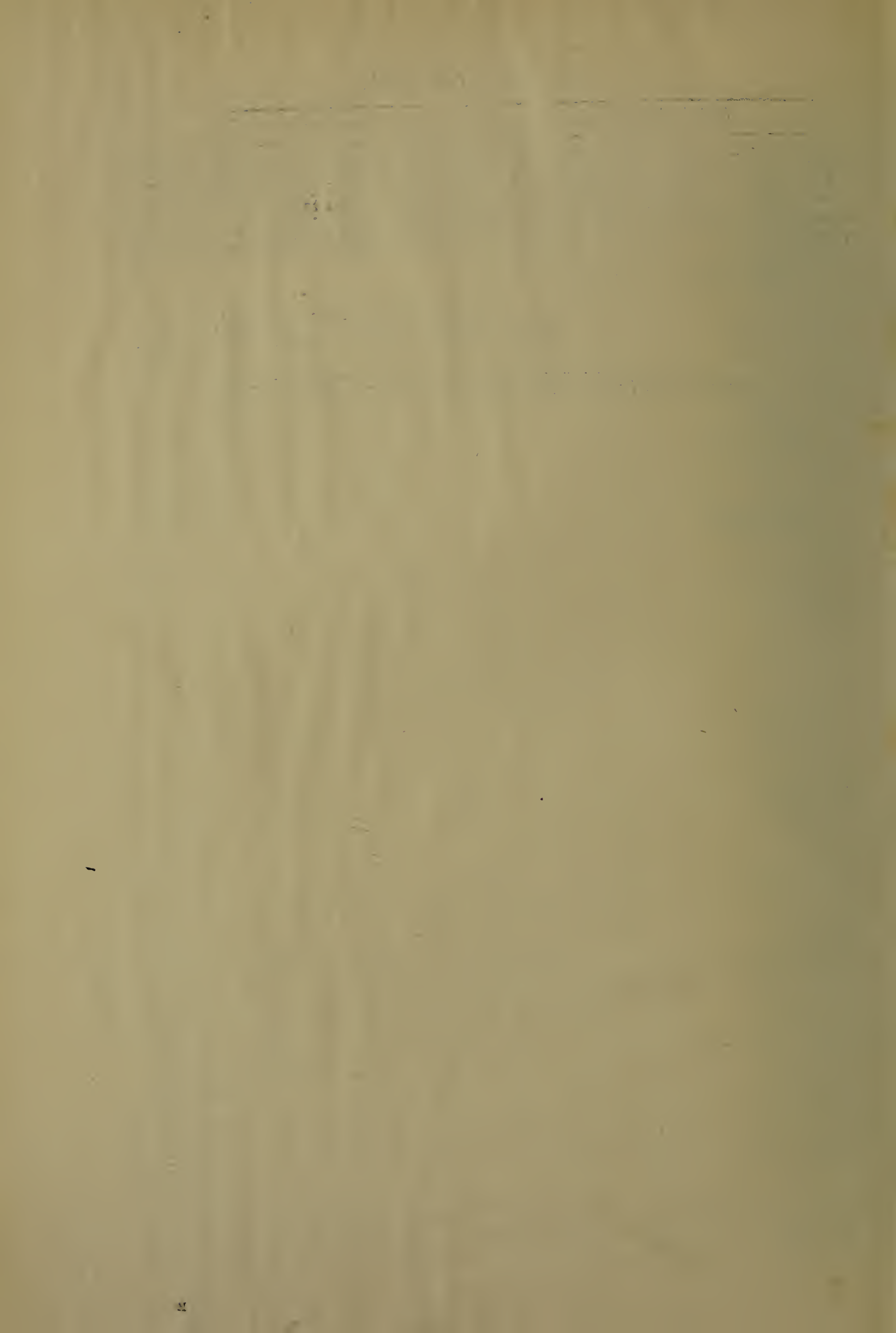
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[This Drawing is a reproduction of the Original on a reduced scale.]

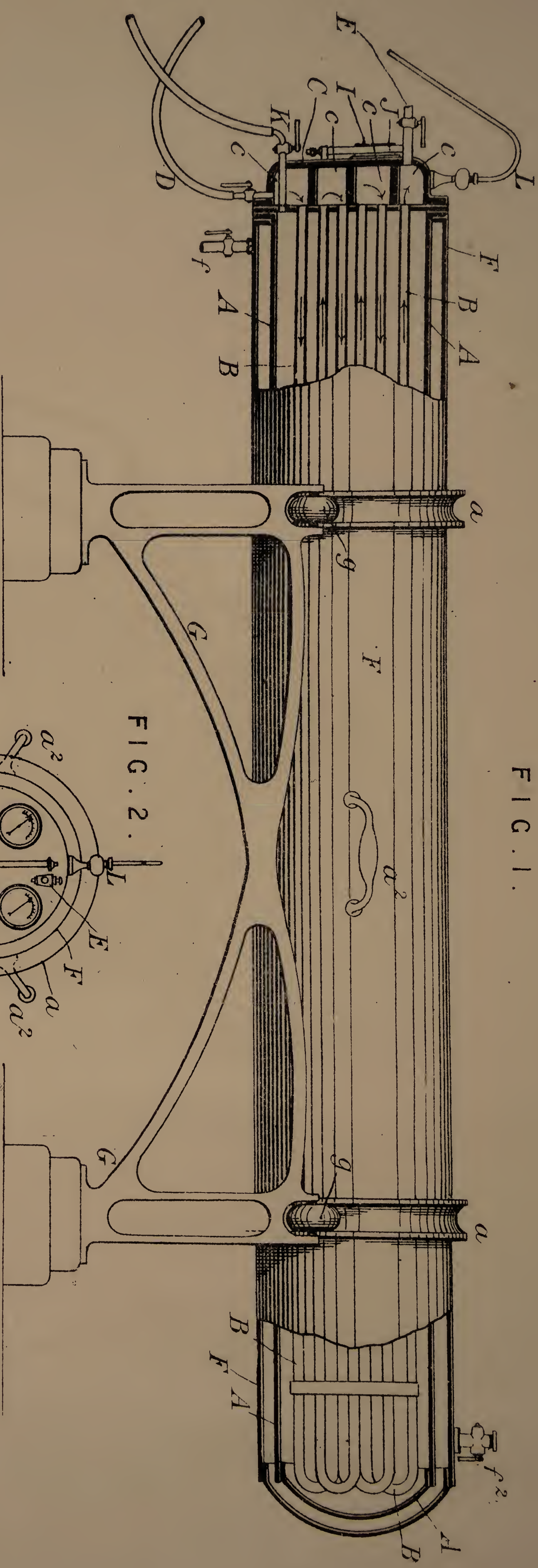


FIG. 1.

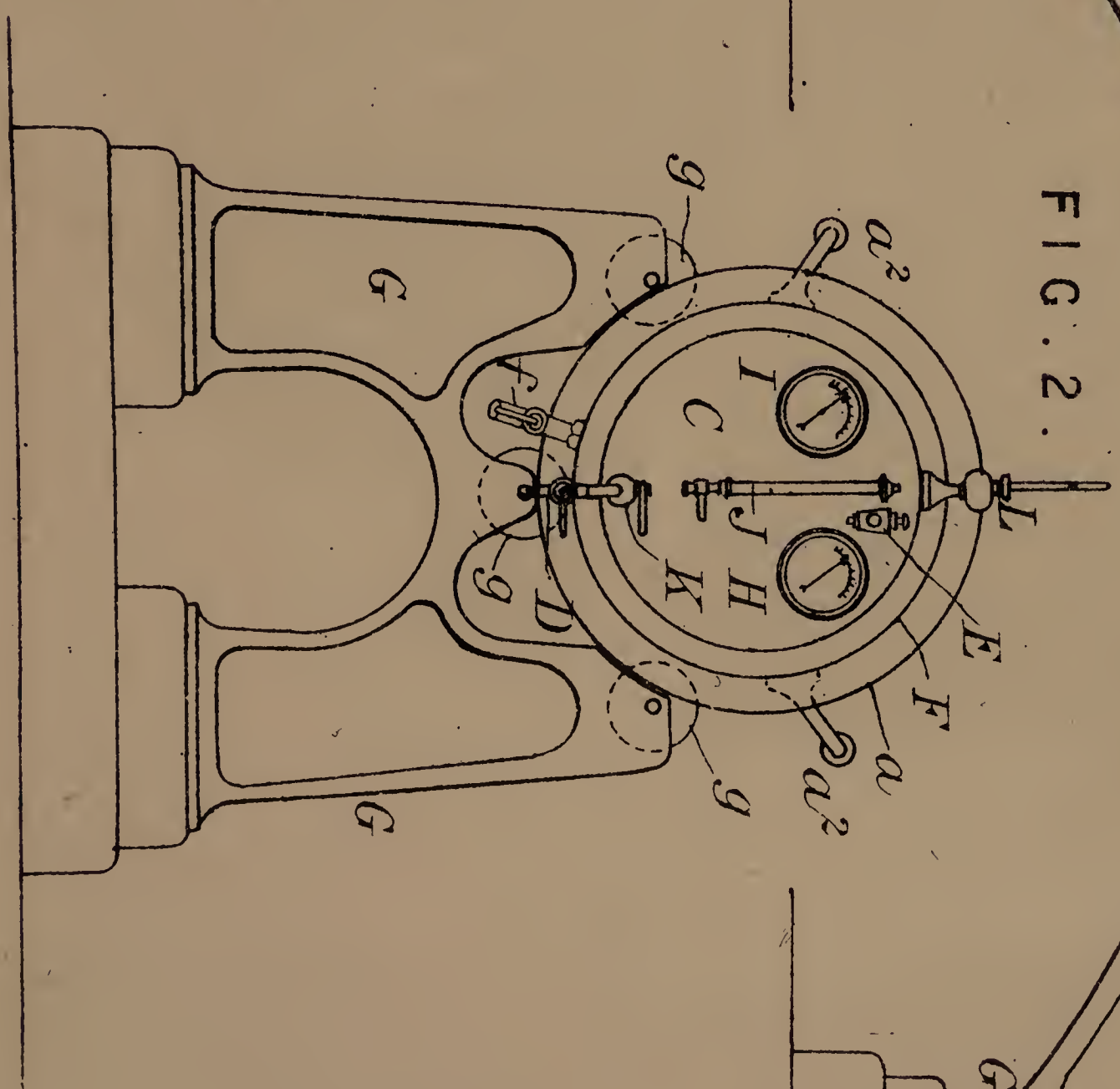


FIG. 2.



